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H1Q QDU QKN
H2E EHC

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GB 2276274 A GB 2255447 A EP 0669672 A1
US 4969842 A

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INT CL[6] H01Q 1/22 1/24 , H01R 9/09 , H04B 1/08 1/38 , H05K 1/18 7/00
ONLINE:WPI,EPODOC,PAJ

(54) Abstract Title
An antenna for edge mounting on a PCB

(57) A radio device is disclosed which comprises an antenna (20) and a PCB (10). The antenna (20) is a unitary structure and is edge mounted onto the PCB (10). No additional fixing means such as screws or soldering are required. Guiding and retaining means and interference fit are disclosed.

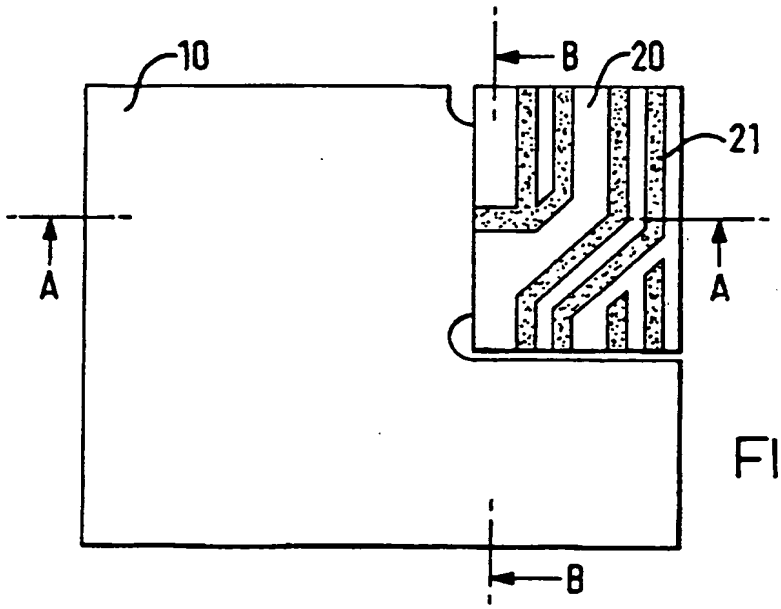


FIG.1

GB 2 345 208 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

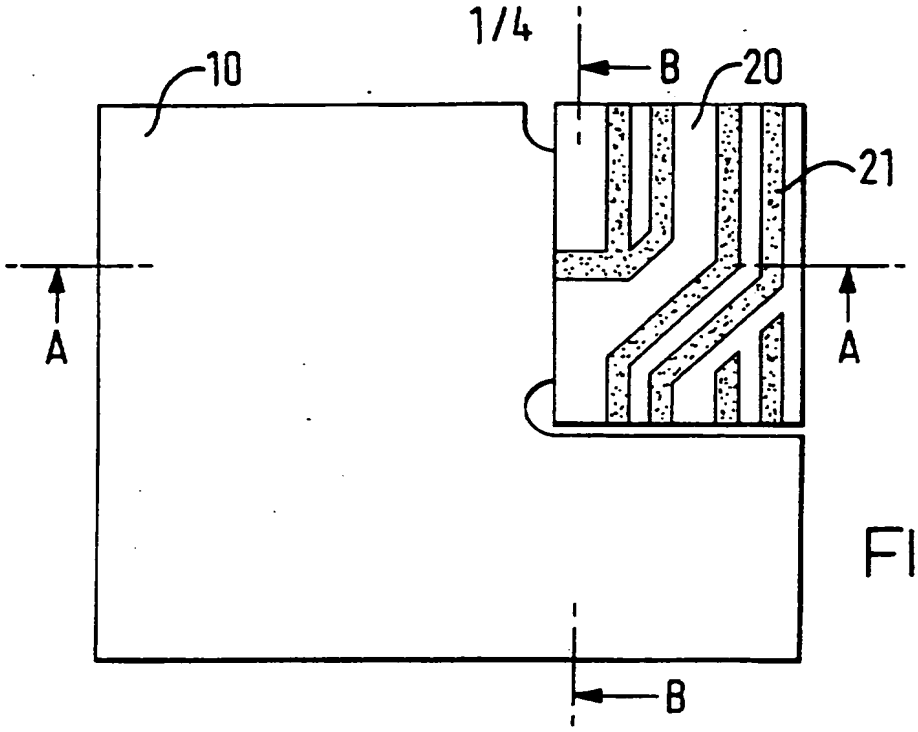


FIG.1

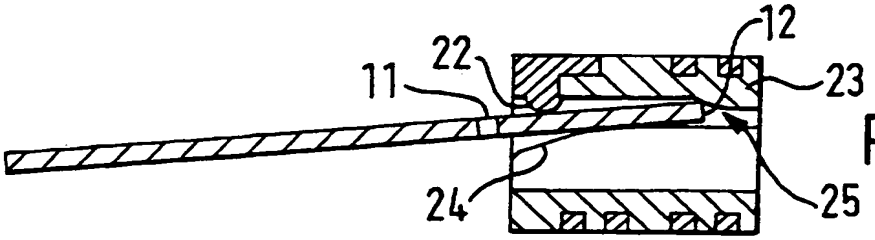


FIG. 2a

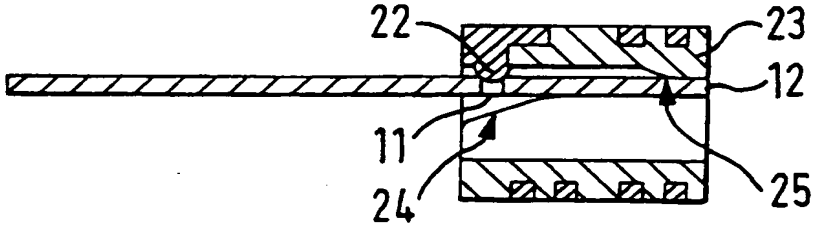


FIG. 2b

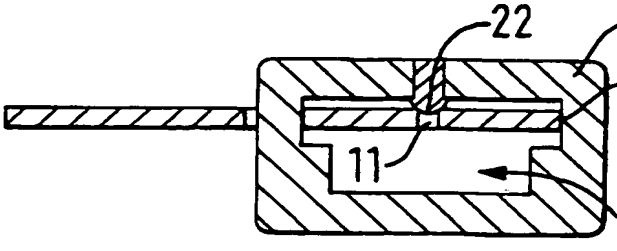


FIG. 2c

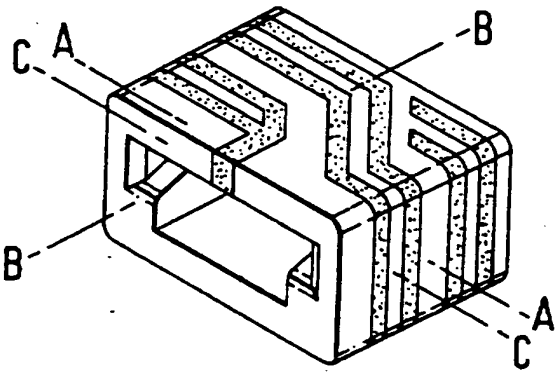


FIG. 3a

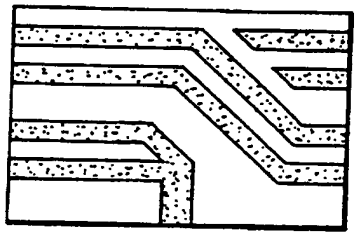


FIG. 3b

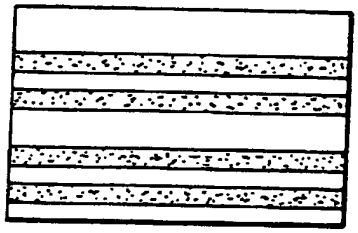


FIG. 3c

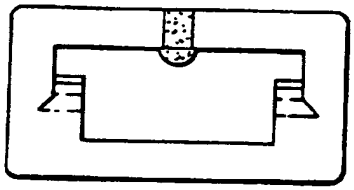


FIG. 3d

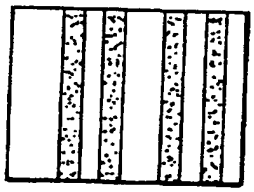


FIG. 3e

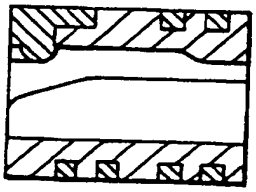


FIG. 3f

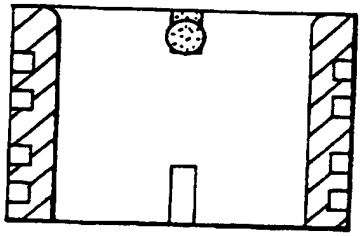


FIG. 3g

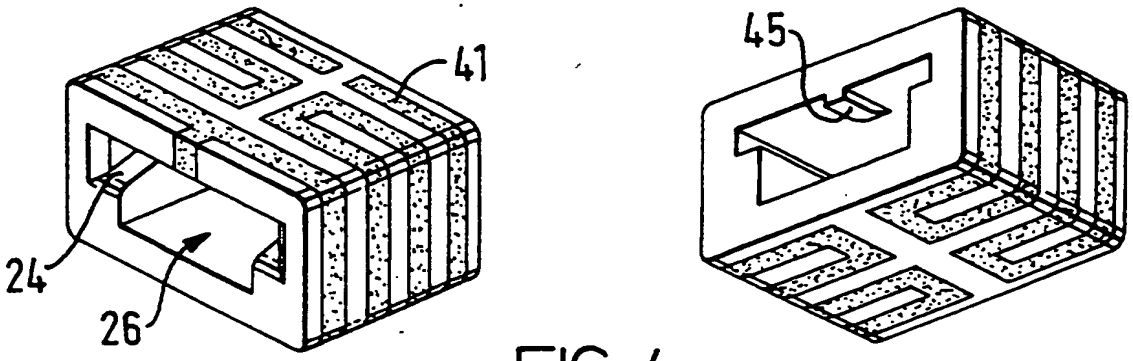


FIG. 4

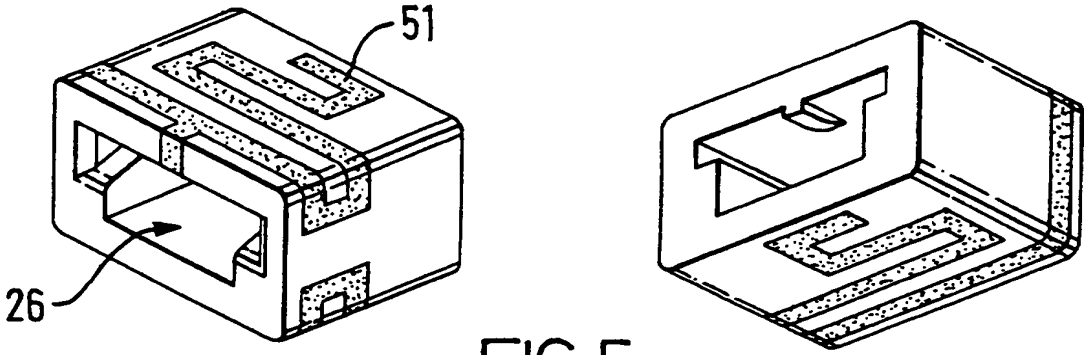


FIG. 5

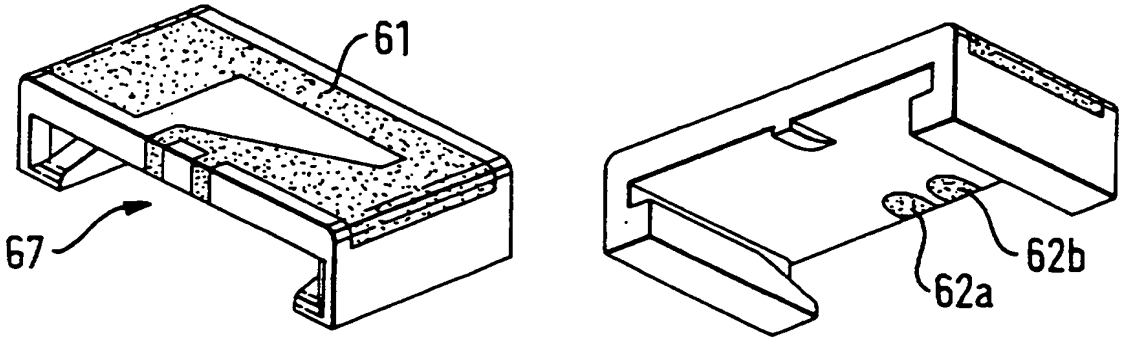


FIG. 6

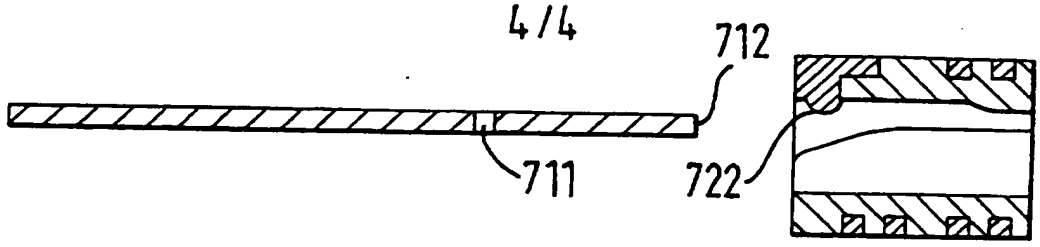
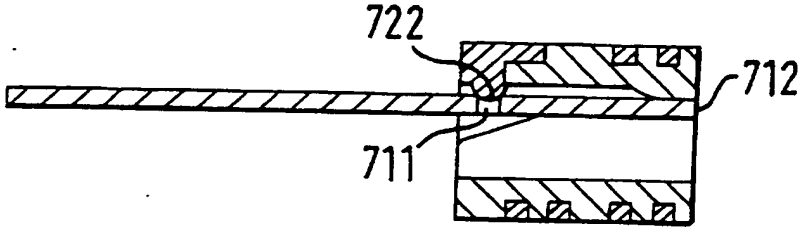


FIG.7



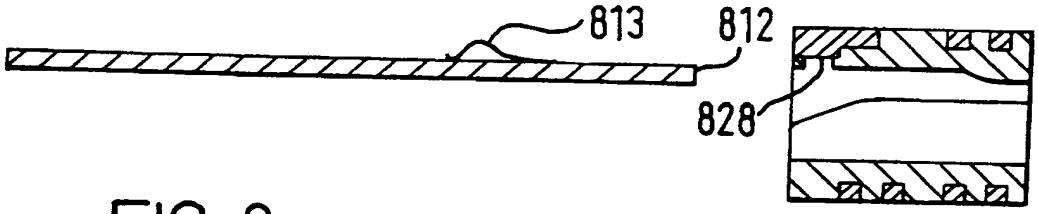
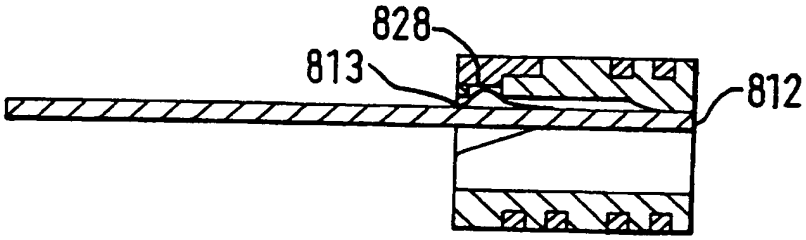


FIG. 8



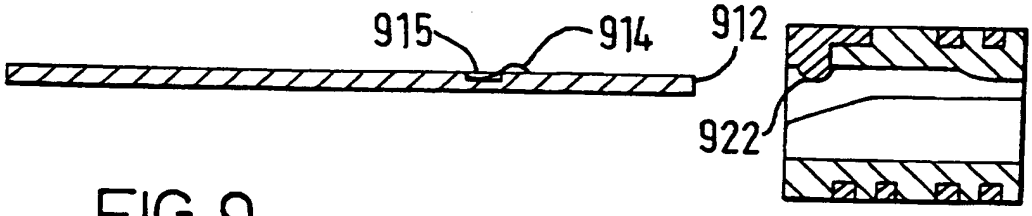
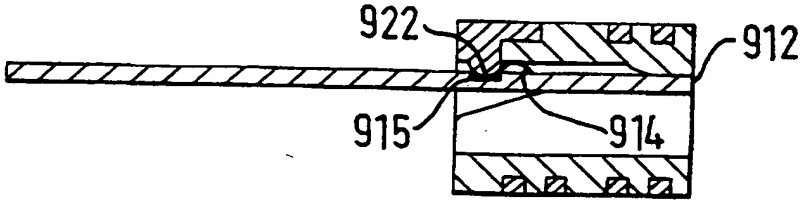


FIG.9



A RADIO DEVICE

The present invention relates generally to radio devices and antennas therefor. In particular, it relates to the connection of an antenna to a circuit board of such a device.

Antennas are used in many electronic products. There is a need to streamline them to reduce the cost of assembly of antennas, especially in high volume consumer products such as radio telephones. An antenna is typically soldered or screwed into place on a circuit board. This is time consuming and requires special equipment. Then electrical feed and ground connections to the antenna are typically provided separately, in a similar way, requiring further manufacturing steps and connecting materials.

Also, there is a tendency nowadays for portable electronic products such as radio telephones to become increasingly compact.

According to the present invention there is provided a radio device comprising an antenna, and a circuit board comprising a contact region for providing electrical connection to radio circuitry, wherein the antenna comprises a recess for receiving at least part of the circuit board edge first, and the contact region is inserted in the antenna recess such that the antenna is electrically coupled to the radio circuitry.

A reduced circuit board area is required for the antenna of this device as compared with a device having an equivalent surface mounted antenna. One reason for this is that the external surface area of the antenna is increased per unit circuit board space as a consequence of the antenna being edge-mounted on the circuit board. The edge-mounted antenna inherently

surrounds more than part of the top face of the circuit board. It may go round the edges and lower part of the lower face of the circuit board too.

Preferably the antenna comprises a conductive element for connection to the contact region of the circuit board, on at least part of its external surface.

The antenna may comprise a guide groove for guiding the circuit board into the recess. This is advantageous as it limits the length of the PCB in the antenna recess.

Preferably, at least part of the recess of the antenna is deeper than the depth of the circuit board, as this may provide more space saving. For example, components may be placed on the PCB under the antenna. Alternatively, the conductive element may be apparent on an internal surface of the antenna which would result in an overall decrease in size of the antenna and thus PCB space required.

In a preferred embodiment, the radio device comprises a latch for latching the antenna in place with respect to the circuit board. Such a latch eliminates the need for soldering, heat staking etc. and thus simplifies assembly of the radio device. The latching may be provided by a number of alternative arrangements. For example, the latch may comprise a resilient member provided by the antenna and biased towards the surface of the circuit board, or vice versa. Also, the resilient member may comprise a protrusion and the surface a discontinuity or vice versa. Advantageously, the protrusion and discontinuity provide both latching and electrical coupling. Indeed, it is advantageous if the antenna at least is a unitary structure, as it is simpler to manufacture and fit.

Alternatively, the resilient member and surface may both comprise protrusions. In this case, one protrusion may be part of the circuit board and the other part of the antenna conductive element, for example. In this event the circuit board contact region may be provided on the opposite side of the circuit board protrusion to the circuit board's insertion edge.

The radio device may also comprise a restrainer for restraining movement of the antenna and circuit board once latched, so as to maintain electrical coupling of the antenna and radio circuitry. This may provide further fixing and support, and may be especially advantageous if the contact region is some distance from the inserted edge of the circuit board.

The restrainer may take various forms. In a preferred embodiment, it is provided by the antenna being an interference fit with the circuit board. In this case, a rear portion of the recess may provide this interference fit, and a forward portion may be tapered to assist insertion of the PCB into the antenna recess.

Alternatively, the restrainer may comprise a clip or clips.

One form of antenna which is particularly useful for implementation of the invention is a moulded interconnection device (IMD) antenna, particularly as it can be simply moulded as a unitary structure.

According to another aspect, there is provided an antenna for use in a radio device of the present invention.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 is a plan view of an antenna mounted on a PCB according to a first embodiment of the present invention;

Figure 2a is a cross-section of Figure 1 along line A-A showing fitting of the PCB and antenna;

Figure 2b is a cross-section of Figure 1 along line A-A with the antenna in place on the PCB;

Figure 2c is a cross-section of Figure 1 along line b-b with the antenna in place on the PCB;

Figure 3 illustrates different views of an antenna such as that shown in the embodiment of Figures 1 and 2 in which:

Figure 3a is the perspective view;

Figure 3b is the top plan view;

Figure 3c is the bottom plan view;

Figure 3d is the cross-section along line a-a of Figure 3a;

Figure 3e is the side view;

Figure 3f is the cross-section along line B-B of Figure 3a;

Figure 3g is the cross-section along line C-C of Figure 3a;

Figure 4 illustrates a coupled meander antenna design;

Figure 5 illustrates a tapered single meander antenna design;

Figure 6 illustrates a multiple connection planar antenna design; and

Figures 7-9 illustrate alternative latching arrangements.

A preferred embodiment of the invention is illustrated in Figures 1 and 2. Figure 1 shows the plan view of a PCB 10 and an antenna 20, such as those suitable for use in a radio device. Figures 2a and b show a cross-section of Figure 1 along line A-A, Figure 2 illustrating the fitting of the PCB 10 and antenna 20, and Figure 2b showing the antenna 20 in place on the PCB 10. Figure 2c illustrates a cross-section of Figure 1 along line B-B.

In this embodiment, the antenna 20 is edge-mounted upon a corner of the PCB 10. However, depending upon the relative sizes of the PCB 10 and antenna 20, the antenna could cover the whole of one edge of the PCB, and either the whole or part of the main face of the PCB 10.

The antenna 20 comprises a main body 23 of a suitable insulating material, such as a plastics material, and a conductive element 21 made of a metal or mixture of metals such as copper, nickel and gold.

The main body 23 has a recess 26 for receiving part of the PCB 10. The recess is sized to accommodate insertion of the PCB 10, edge first. In this embodiment, the recess 26 comprises a front portion 24 and a rear portion 25. The rear portion 25 of the recess 26 provides an interference fit with the PCB, whilst the side walls of the forward portion 24 at least are ramped, so that they taper from the opening to the rear portion 25. This facilitates insertion of the PCB 10 into the antenna recess 26. Preferably, a portion 26a of the recess 26 is deeper than the thickness of the PCB 10 so that the antenna 20 clears components on a corresponding region of the PCB. This reduces the PCB space required for the antenna 10 and thus the overall size of the device.

The conductive element 21 is provided at least on the top face of the antenna 20. However, the sides and rear surfaces are preferably utilised in addition, thereby enabling the antenna, and thus the PCB space required by it, to be reduced in size. In this embodiment, a portion 22 of the conductive element 21 protrudes into the antenna recess 26.

A contact region is provided at a position on the PCB 10 which would contact this protrusion 22 when the PCB 10 is inserted into position in the antenna recess 26. In this embodiment, the contact region takes the form of a

conductive plated hole 11. This plated hole is electrically connected to radio circuitry (such as an antenna feed) on the PCB 10.

The antenna 10 may be manufactured using a number of methods. One such method is using MID (Moulded Interconnection Device) manufacturing technology. The present embodiment could be manufactured in two shots using this technology. Alternatively, the antenna may be formed by wrapping a metal strip supported on a carrier medium such as a plastic film around a main body of suitable insulating material. The metal strip may be a mixture of copper nickel and gold, is corrugated and forms a series of castellations. The method of forming the corrugated metal strip on a plastic film may be by any suitable method such as printing, vacuum deposition, sputtering, 3D image transfer or the like. The insulating material making up the main body may be a plastics material similar or even identical to that from which the plastic film is formed. By appropriate treatment, such as heat treatment, a substantially homogenous composite antenna may be formed comprising the main body, plastic film and corrugated metal strip.

The fitting of the antenna 20 on the PCB 10 will now be described. An edge 12 of the PCB 10 is inserted into the front portion 24 of the antenna recess 26. Clearly, insertion can take place either by moving the PCB 10 towards the antenna 20, the antenna 20 towards the PCB 10 or a combination of such movement. However, generally the PCB will be fixed in position in a device, and thus the antenna will be inserted over the edge of the PCB. The PCB 10 is slid up the ramp in the front portion 24 of the antenna recess 26 and into the rear portion 25. As the surface of the PCB makes contact with the conductive element protrusion 22, the upper section of the antenna flexes or deforms to allow the PCB to be slid beneath it. Once the PCB has been inserted to the position where the antenna protrusion 22 and PCB hole 11 oppose each other, the PCB 10 and antenna 20 latch together, by virtue of

the protrusion 22 entering the hole 11. This has the effect of returning the upper section of the antenna to its normal bias position, and also effecting electrical contact between the conductive element 21 and radio circuitry on the PCB. The rear portion 25 of the recess 26 restrains the PCB 10 once in place, as a result of its interference fit with the PCB 10. As an alternative to the interference fit, an arrangement may be provided with clips to perform the same restraining function.

The addition of a restraint may not be necessary at all, depending on the design of the PCB and antenna. For example, latching itself may be sufficient to retain connection for example if the hole 11 is close to the edge 12 of the PCB 10. This embodiment of the present invention provides an antenna which is small, compact, cheap, easy to manufacture and easy to assemble in a device such as a radio telephone. It eliminates the need for solder joints and therefore provides improved reliability.

Figure 3 illustrates different views of an antenna 20 such as that in the embodiment of Figures 1 and 2. Figure 3a illustrates the antenna recess 26 in more detail. As can be seen, this recess 26 has guide channels in the internal side walls which guide the PCB 10 into the recess 26, and an extended depth 26a in between these side walls. The front portion of the guide channels are ramped to ease insertion of the PCB, and the rear portion provides an interference fit with the PCB.

Also, as illustrated in Figures 3b, c and d, the conductive element 21 is present on the top, bottom and sides of the main body, thus optimising the external surface area available when the antenna is edge-mounted on the PCB (for example when compared to an equivalent surface-mounted antenna). Consequently, the main faces of the antenna can be reduced in size, thus resulting in less necessary PCB space.

This embodiment illustrates an EMSCA diversity antenna suitable, for example, for Japanese PDC radio communications device. However, the invention is not restricted to the arrangement shown in this embodiment. For instance, alternative radiation patterns are shown in Figures 4 to 6 below and alternative latching means are shown in Figures 7 to 9.

As mentioned above, Figures 4 to 6 show alternative antennas which can be edge-mounted on a PCB. Figure 4 illustrates a coupled meander or castellation design, Figure 5 illustrates a tapered single meander or castellation design, and Figure 6 illustrates a multiple connection planar design. They each exemplify an arrangement for providing an interference fit with the PCB, namely the provision of a ramped surface protrusion 45 positioned approximately centrally across the width of the device and at the rear of the recess. This arrangement is advantageous, as it minimises the quantity of insulation material required, and thus reduces the weight of the antenna. Another way of reducing the weight of the antenna, (particularly where top and side external surfaces are sufficient for the conductive element), is to eliminate the bottom surface from the design, other than is necessary to define the PCB guide channels (see Figure 6).

The embodiment shown in Figure 6 has an antenna with multiple connections – two conductive element protrusions 62a, 62b. Clearly, a corresponding PCB 10 would have two corresponding contact regions in this instance.

Figures 7 to 9 illustrate alternative latching mechanisms which may be employed in a device of the present invention. The embodiment shown in Figure 7 corresponds to the latch previously described with reference to Figures 1 and 2, and will therefore not be described further here except to say that such an arrangement is easy to manufacture. Figures 8 and 9 are

slightly more complicated to manufacture, but still benefit from the ease of the mounting of the antenna 20 on the PCB 10.

Figure 8 operates, in effect, as the mechanical opposite of Figure 7. That is, the PCB comprises a protruding resilient member 813 which is normally biased upwards, and the antenna conductive element provides a recessed contact region 828. As the edge 812 of the PCB is inserted into the antenna recess, the resilient member 813 is deformed towards the surface of the PCB. Once the protruding resilient member 813 opposes the recessed conductive element 828 of the antenna, it returns to its normal biased position; the PCB and antenna are latched together, and the protrusion 813 and contact region 828 make contact.

Turning now to Figure 9, the antenna of this embodiment is the same as that of Figure 7. That is, it comprises a conductive element with a protrusion 922. However, the PCB is also provided with a protrusion 914 and the PCB contact region 915 in this case is provided on the surface of the PCB on the opposite side of the PCB protrusion 914 to the insertion edge 912. In this embodiment, the PCB slides into the antenna recess until the protrusions 914 and 922 make contact. During this period, the antenna protrusion 922 slides up and over the PCB protrusion 914 and the upper portion of the antenna is flexed or deformed in the process. Once the protrusions have passed each other, the upper portion of the antenna returns to its natural biased position, thus lowering protrusion 922, and preventing return movement of the PCB. The contact 915 is positioned to make contact with the protrusion 922 at this time.

The present invention includes any novel feature or combination of features disclosed herein either explicitly or any generalisation thereof irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention.

CLAIMS

1. A radio device comprising:

an antenna; and

a circuit board comprising a contact region for providing electrical connection to radio circuitry;

wherein:

the antenna comprises a recess for receiving at least part of the circuit board edge first; and

the contact region is inserted in the antenna recess such that the antenna is electrically coupled to the radio circuitry.

2. A radio device as claimed in claim 1, wherein the antenna comprises a conductive element for connection to the contact region on an external surface.

3. A radio device as claimed in claim 2, wherein the external surface surrounds at least one of the inserted edges of the circuit board;

4. A radio device as claimed in claim 2 or 3, wherein the external surface of the antenna comprises at least three substantially planar surfaces.

5. A radio device as claimed in any preceding claim, wherein the antenna comprises a guide groove for guiding the circuit board into the recess.

6. A radio device as claimed in any preceding claim, wherein at least part of the recess is deeper than the depth of the edge of the circuit board.

7. A radio device as claimed in claim 6, wherein walls of the recess provide shielding.

8. A radio device as claimed in any preceding claim, comprising a latch for latching the circuit board and antenna at a relative position to maintain electrical coupling of the antenna and radio circuitry.

9. A radio device as claimed in claim 8, wherein the latch comprises a resilient member on one of the circuit board and antenna, biased towards a surface of the other.

10. A radio device as claimed in claim 9, wherein one of the resilient member and the surface comprises a protrusion, and the other comprises a discontinuity.

11. A radio device as claimed in claim 10, wherein the protrusion and discontinuity also provide electrical coupling of the antenna and radio circuitry.

12. A radio device as claimed in claim 10 or 11, wherein the discontinuity is an opening in the surface.

13. A radio device as claimed in claim 9, wherein both the resilient member and surface comprise a protrusion.

14, A radio device as claimed in any preceding claim, comprising a retainer for retaining the antenna and circuit board at a relative position to maintain electrical coupling of the antenna and radio circuitry.

15. A radio device as claimed in claim 14, wherein the restraining means comprises at least the rear portion of the recess provided to interference fit with the circuit board.

16. A radio device as claimed in claim 15, wherein the forward portion of the recess is tapered towards the rear portion.

17. A radio device as claimed in claim 14, wherein the restraining means comprises a clip.

18. A radio device as claimed in any preceding claim, wherein the antenna is an in mould decorated antenna.

19. An antenna for use in a radio device as claimed in any preceding claim.

20. A radio device substantially as hereinbefore described with reference to, and/or as illustrated in any of Figures 1 to 9 of the accompanying drawings

21. An antenna device substantially as hereinbefore described with reference to, and/or as illustrated in any of Figures 1 to 9 of the accompanying drawings.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 9828537.2 **Examiner:** D Midgley
Claims searched: 1-21 **Date of search:** 10 March 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H1Q QKE,QKN H2E EHC H3Q QAA,QACA

Int Cl (Ed.6): H01Q 1/22,1/24 H01R 9/09 H04B 1/08,1/38 H05K 1/18,7/00

Other: ONLINE:WPI,EPODOC,PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2276274 A	(SEIKO) See, for example, figure 1(a) and 1(b)	1-7,14,18,19
X	GB2255447 A	(MOTOROLA) See, for example, figures 1A and 1B	"
X	EP 0669672 A1	(ASCOM) See, for example, figure 2	"
X	US 4969842	(AMP) See, for example, figure 1	"

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.